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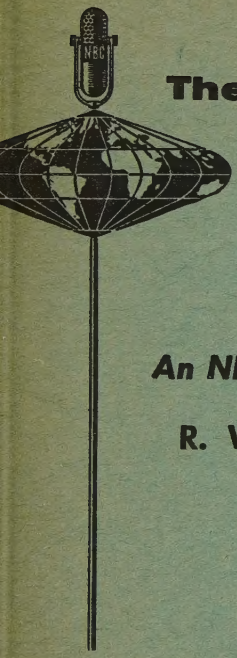
Where Are Tomorrow's Scientists?



The University of Chicago Round Table

An NBC Radio Discussion by

R. WENDELL HARRISON

PAUL DE VRIES MANNING

DONALD A. QUARLES

AARON SAYVETZ

ncluding:

AN OBSTACLE TO PROGRESS

By **William C. Foster**

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AN OBSTACLE TO PROGRESS
By WILLIAM C. FOSTER 1

THE UNIVERSITY OF CHICAGO ROUND TABLE
EDWARD W. ROSENHEIM, JR., *Director*
LEON SCHLOSSER, *Editor*

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Where Are Tomorrow's Scientists?

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MR. SAYVETZ: The problem we are talking about today is one which is deeply felt both in education and in industry. It is appropriate, therefore, that I am joined at the ROUND TABLE here in Chicago by R. W. Harrison and Paul DeVries Manning and, from Washington, D.C., by Assistant Secretary of Defense Donald Quarles.

Gentlemen, where are tomorrow's scientists?

The answer is, I think you will agree, that they are in school today. And, if there are too few students preparing for a career in science and engineering today, there will be too few scientists, engineers, and technicians tomorrow. We are all becoming aware of the consequences for our country's welfare if there are too few scientists tomorrow, and none is more keenly aware of this problem than the persons who are responsible for research and development in connection with national defense. Though the needs of the defense establishment and its industrial base constitute only one aspect of a larger problem, as I think our discussion will show, this is, nevertheless, one of the most dramatic and urgent aspects.

We are fortunate, then, in having as our first commentator, Mr. Donald A. Quarles, Assistant Secretary of Defense, in charge of Research and Development, who speaks from Washington, D.C.

SECRETARY QUARLES: Professor Sayvetz and gentlemen: I appreciate very much the opportunity to join in this discussion with you. I believe you are dealing with a topic of vital importance to the long-range security and welfare of our country. We are all happy with recent events, such as the signing of the Austrian Treaty, which tend to ease the tensions around the world. So long, however, as it is the avowed purpose of Soviet communism to destroy our system of government and freedoms and human decencies upon which it is based, so long as the Communists pursue this end with all their cold-war paraphernalia, of false propaganda, subversion, infiltration, sabotage, and terrorism, we must not be lulled into a sense of security by the comparative calm on the surface. Our civilization could still be destroyed without resort to

hot-war weapons, at least not until it was too late for us to use such weapons effectively to stem the tide. Like it or not, then, there is still the challenge to us to face up to the cold war, with all the resolution and vigor that we would surely muster if we had the excitement and stimulation of the battlefield. The cold war has many fronts, and none can be neglected. The one that I happen to be assigned to might be called the technological front. Let me explain.

It is obvious in retrospect that the last two decades have seen advances in the sciences of aeronautics, electronics, and nucleonics that have revolutionized warfare. The struggle to move ahead on these and other technical fronts is continuing on both sides of the Iron Curtain. This is a technological race that we cannot afford to lose. Basic to our success in this race is our cultivation and conservation of scientific and technical manpower. Such manpower is our really critical resource. One needs only to glance at the "engineers and scientists wanted" advertisements in the press to see how critical the need has become. Here the Soviet challenge is all too apparent. They have recognized the importance of the problem and have made strenuous strides in solving it to the point, in fact, where they are turning out well-trained scientists and engineers at something better than twice our current rate. Our system can, and I believe will, make more effective use of such people than theirs will. I doubt, though, that we can keep ahead in the technological race unless we can improve our system of producing and using specialized manpower. This is the challenge to which, I take it, we are to address ourselves.

If I may be allowed an additional minute or two, I should like to touch on a strictly military aspect of the problem. Conservation of technical manpower means making the best use of it in our national interest. As you know, the President has made recommendations to the Congress, and the Congress is now considering new legislation covering selective service and the national reserve plan. While the outcome is not yet clear, I would like to say that the Administration is well aware of its obligation to sharpen its utilization of technical manpower. As we see it, there is no necessary conflict between the principle, on the one hand, that all young men should share equitably the obligation to serve, and the necessity, on the other hand, that the special talents of scientists and engineers should be used to our best national advantage and should not be wasted. What we need, and what we are working on, is a scheme by which such specialists may render their service,

which I am sure they are all anxious to do, but render it in the fields of their specialization, either in uniform or in the laboratory, according to the needs. This much of the challenge is clearly up to the government. Any help or suggestions from this panel would, of course, be most appreciated. It seems very important to me that the public understand what the cold war is and, in particular, the part that scientists and engineers must play in it.

MR. SAYVETZ: Thank you, Mr. Quarles.

Mr. Quarles has told us that there is a critical problem: a lack of scientific personnel, from the point of view of government, concerned primarily with national defense.

Is there a problem, Mr. Manning, in connection with industry?

MR. MANNING: Yes, I think there is a problem. The problem is to supply the necessary scientists and engineers not only for research and development work but also for the operation of industry and its expansion as fast as industry can take up the scientific advancement that is being made in the research laboratories of the universities, the research institutes, and in industry itself, and for implementing the work as started by such laboratories by such scientists. In other words, the rate of scientific development and scientific discoveries is increasing tremendously. It is almost one of geometrical proportions, and it is very difficult to find men who can carry out that work.

MR. SAYVETZ: So, industry cannot get enough scientists and technically trained people of the kind it needs.

How is the problem felt in education, Mr. Harrison?

MR. HARRISON: The shortage at the present moment is already acute, particularly at the high-school and early college level. Mr. William C. Foster, president of the Manufacturing Chemists' Association, said, at a meeting in Chicago last Wednesday, that one of the universities in this country with more than twenty thousand full-time students in residence will graduate this spring just six chemical engineers and that forty companies are trying to hire them. He took a dim view of prospects for improving the situation in the immediate future. He pointed out that we needed, last fall, seventy-seven hundred more mathematics and science teachers than we could find with proper preparation for the jobs. He indicated that we will not get more than half this number of new teachers in America until after 1960. I spoke to Dr. Luberra,

associate superintendent of the Chicago Public Schools, last week, and he told me that two hundred new science teachers will be needed in the Chicago public schools by 1959 and two hundred and twenty-five more by 1961 just for the Chicago high schools alone.

MR. SAYVETZ: Your first statement made it sound as though the problem were not due merely to a population increase with a slight lag in number of scientific personnel but as though there were an actual decline in the percentage of students who chose scientific careers.

MR. HARRISON: I think the decline does exist, and it is probably absolute as well as relative. The problem is a very curious one, and it may be reflected in the caliber of the men who are today choosing to teach at the beginning levels of students' education in science, so that there is a lack of stimulus.

MR. SAYVETZ: Would you say, Mr. Manning, that, even if there were not a cold war (the existence of which does create a demand for technologists of all kinds), there would be a shortage from the point of view of industry because of the decline in the choice of scientific careers by young people?

MR. MANNING: There are two factors, in my opinion, that are working toward the same end. One is the factor that Mr. Harrison pointed out—there is a decline in the number of students who are majoring in professional scientific work. The other is the factor which I mentioned last—the rate of scientific discovery and research is so rapid that it is requiring more and more men and requiring them at a greater rate than we have been able to supply them.

MR. SAYVETZ: In other words, there would really have to be an increase, a great increase, in the number of students who choose a scientific career merely to keep pace with the peacetime demands of industry in technology in our society.

MR. MANNING: That is right. The number of scientific research engineers and chemists, research people in industrial research alone, has almost doubled since 1952.

MR. HARRISON: I can go a little further with that. In the first half of this century the number of trained scientists in this country has increased ten times as fast as the population of the country has increased. This, then, does indicate that there has been an increase in scientists. The question is: What is the problem today? And it is a problem, of

course, of great demand in industry and in schools, both with the growing new population of schools and with the great expanse of industrial needs for trained scientists.

MR. SAYVETZ: So, we are in agreement with Mr. Quarles that there is a critical problem, a critical shortage, of scientific personnel today. Could we turn, now, to the question, "Why?" Do you have any opinions, gentlemen, as to why the rate of production, if I can use an industrial term (it seems appropriate really), of scientists in our schools and colleges has taken a turn downward and so created a very difficult and even dangerous problem?

MR. HARRISON: It is a very complicated problem, and I am sure I do not know the answer. I believe the first place to look for it is at the high-school level. The lowered birth rate of the depression years, the effects of the war, the great expansion in industry, the flight of scientifically trained people into other occupations—all, somehow, conspire to have less available science teaching in the high schools, at least at a level which will stimulate the interest of students in science. And so we see a decrease in the number of high-school students preparing for science at the very moment that we need an increase.

MR. SAYVETZ: Your mentioning the depression, which we all prefer to forget about, seems to imply an economic factor which may even be present today. Did you mean to infer something along that line?

MR. HARRISON: The primary effect I was speaking of, with respect to the depression, was the reduced birth rate of the depression, which, of course, is a reflection of economic factors. The lowered birth rate of the depression resulted in a reduced number of present-day college students in training for science careers.

MR. SAYVETZ: Which reduced the number of high-school teachers . . .

MR. HARRISON: That is correct.

MR. SAYVETZ: . . . which further discourages and reduces the number of students who will choose such careers. But, if I may persist, do you think there is an economic factor in the flight of high-school teachers, even today, from that profession?

MR. HARRISON: I would like to hear Mr. Manning speak on this one, but I personally believe there is. If industry needs more scientists than it can get, industry has the means to increase their salaries rapidly

enough to attract them away from other places. If the voters do not vote higher taxes for the support of schools, the schools cannot raise the salaries of teachers, and teachers who are competent to do these jobs leave the schools and go into industry.

MR. MANNING: We are all trying to do a number of things. In the first place, I think that a little shortage of scientists is probably a very good thing because it has resulted in an increase in salaries of chemists and engineers to the point where I believe they are making more in line with what they should make. And if you compare the income now of professionally trained men, such as lawyers and doctors, you will find, I believe, that the chemists are right in line and perhaps have a little bit of an advantage over them. But we are recognizing that we have got to show the teachers in high school more of the interesting things that industry is doing in chemistry, in physics, and in engineering, and many of our industries are now taking on high-school teachers in the summer, during their vacation, in order to show them what is being carried out in industry and to help them understand the applications of science and of chemistry. And in many industries, for instance, our own, we are taking on a certain number of young high-school students to work in our laboratories in the summer, and university students also, as well as science teachers.

MR. SAYVETZ: Of course, if there were an adequate number of high-school teachers, it is clear that they should be familiar with developments in industry as well as in pure science. But how does industry respond to the notion that there are an inadequate number of high-school teachers—because they are attracted elsewhere, including industry? If there are an inadequate number of high-school teachers, industry is not going to get enough scientists and engineers to meet its need. Does industry have anything to report? What thinking is there on the subject of the shortage of teachers in our public and private schools?

MR. MANNING: The shortage is very much recognized, but the great problem is: What can we do to alleviate that shortage? And what we are trying to do is to bring the knowledge of the teachers up to date; to furnish them with opportunities of understanding the importance of their part, you might say, in industry and in the training of men for industry.

MR. HARRISON: I think this problem is not altogether a problem of industry, Mr. Sayvetz. The professors in the universities do not spend

enough effort with the students in putting before them the opportunities that exist at the earlier levels of science training. The professors tend to tempt most of the students who seem to have the capacities for good work in industry or at the university graduate level into those areas rather than to put considerable thought into the question of getting some of the competent ones into high-school teaching. This, of course, does not pay any dividends, because it soon dries up the source of supply.

MR. SAYVETZ: I take it that, if dollars and cents were the only things which determined the choice of profession, we would have very few teachers; but, obviously, since we do have many and devoted teachers, there must be other values in teaching which we must call to the attention of boys and girls in the choice of their careers. What can the schools do in this respect?

MR. HARRISON: If the professors sought to interest some of their brightest students in the career of high-school teaching and if some opportunity were made available to them, either through the influence of the voter or through the influence of the cooperation of the university with the high school, so that these students could make their contacts in the research laboratories of the universities and of industry while they are doing their teaching, it might very well work into the joint kind of opportunity for high-school teachers that already exists for college teachers.

MR. SAYVETZ: Is it your general point, then, that there may not be any specific things that we can do to attract students to science but that, if the general health, the whole general health, of the school system were raised with adequate facilities, we would automatically get more boys and girls, better educated, and more interested in education?

MR. HARRISON: I believe this is true.

MR. MANNING: The important thing in my mind is to develop the opportunity for people who are teaching to give personal inspiration to the young people in high schools and in universities.

MR. HARRISON: I would like to make the point, Mr. Sayvetz, that the shortage of high-school teachers is not limited to the sciences. It is peculiarly aggravated in the sciences because of the simultaneous expansion of need for scientists, but there is an acute shortage of teachers at all levels and all areas of high-school teaching. So, we have a prob-

lem in this country of getting trained people into the field of high-school education, among them a particularly acute one being teachers in the area of science and mathematics.

MR. SAYVETZ: Mr. Quarles in his talk mentioned, with respect to the cold war, that we are in a kind of race. Now I assume that in our form of government there are certain devices, compulsive devices, that are not available to us. (We want to retain our form of government.) What are some of the ways in which we can improve our educational system without resorting to compulsion? Is it necessary in our country simply to increase the numbers of students who have educational opportunities in order that a certain fraction of them, a greater fraction, will become teachers? That is, do the statistics show that, of all the students who go to grammar school, an insufficient fraction goes to high school and an insufficient fraction of those go on to college? Is that a route that perhaps might be tried in our own society?

MR. HARRISON: I think, in our own experience, federal aid to the G.I. indicated that the number of students who would grasp at the opportunity for higher education would be greatly increased if they did not, themselves, face economic factors. It is very clear. And among these students who economically cannot afford to go to college, and therefore cannot prepare for teaching or for science careers in industry, there are a great many who, if funds were made available through scholarships, federal aid, or other sources, would be available for this who are not now available simply because of lack of economic backing.

MR. SAYVETZ: We seem to have agreed that there is a critical problem. We seem to have put our finger on the bottleneck in the schools, particularly the high school. Would you say that the elementary school, the teaching in the elementary school, was part of this problem?

MR. HARRISON: I do not see how it can be directly a part of the problem. Perhaps indirectly it has many effects on it. Maybe Mr. Manning has some views on this, as he has some children in school.

MR. MANNING: I agree with you on that. It undoubtedly has an indirect effect, but I believe our principal difficulty, our principal problem, is to raise the salaries, to raise the amount of money that is available for high-school teachers, and to raise the prestige of their profession, to make them realize what an important part they play in the future of our country.

MR. SAYVETZ: Do you have any ideas as to how we can increase the prestige of the teaching profession?

MR. MANNING: Yes, I think we can do that by showing them what part they are playing in the production of engineers and scientists, by making them realize that, after all, it is they who initiate the desire in the minds of these young people to become scientists and engineers.

MR. SAYVETZ: We can sell products of almost any kind we devise; we should be able to sell the teaching profession to young men and women. A very aggravating part of the problem is the speed with which the shortage has to be met, both for peacetime needs of industry and for the needs that arise because of our political conflicts in the world today. Perhaps if there were plenty of time, we could evolve, as we usually do, a better educational system to supply our needs. But what is to be done in a short time with this problem? Or, do you agree, gentlemen, that speed is the thing that aggravates the problem?

MR. HARRISON: I believe that speed aggravates the problem, and I believe we have to do something about it rapidly for now. I am sure that, to the extent that we are successful, the expansion of our training program in high schools and colleges will, unless we watch it further, make for an oversupply and thereby create economic hazards for the people who will be going into the science field in the future. This is a cyclical sort of development.

MR. MANNING: I do not think I can agree with you there, because I think that we are carrying out scientific developments so rapidly—scientific research is bringing developments so rapidly—that we will more than take up the slack.

MR. SAYVETZ: In any case, there is an urgent and critical problem of developing adequate scientific personnel for the continuing welfare of our country. And if the needs of national defense have highlighted this problem and urged us to think about solutions, why even that is a good, in the same sense in which wartime research has given us much that we use in peacetime. In a way, the situation today is like it was a hundred years ago when scientists were needed but education was entirely classical; and then it was realized that, if the schools were to produce scientists, there needed to be teachers of science. And that, I take it, is the solution that we must look toward today.

AN OBSTACLE TO PROGRESS*

By WILLIAM C. FOSTER

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This is Chemical Progress Week. During this week the men and women of the American chemical industry are, with justifiable pride, pointing out to fellow-Americans what the combination of science and industry has contributed to giving us a better life. It is an inspiring story. Progress has been enormous; it is difficult to think of anyone in our country who is not benefiting from it in some way every day. However, today I will be talking to you about a serious obstacle now in the path of such progress.

This is the education problem. It has been talked about so much that, even though I am convinced that we understand it imperfectly, it is evident that a great many of us realize it is there. Such broad awareness of the problem is the best hope we have that it will be solved.

The American people seem to have a remarkable capacity for letting a national problem develop until it reaches serious proportions. Then somehow the people themselves take over and through expression of their individual wills solve it. The reason, often not recognized in other countries and even by many Americans, is that our people have learned to understand their democracy and how to make it work.

In the chemical industry the problem is serious chiefly in the fields of scientific and technical education. Its symptoms are apparent today and show up in a number of ways. The new graduate, just hired, sometimes has not been adequately trained, and therefore his employer must spend more time and money to get him through his apprenticeship to the point where he is paying his own way and producing for his company. Perhaps the worst part about this is the discouragement it can mean for the young man. Often when a new project is about to be undertaken, it is difficult for companies to find men with sufficient training and experience to operate it. As our industry expands, men to fill the growing number of top management positions become increasingly scarce.

The problem shows up most drastically today when, facing the herculean research tasks we must solve, we know that many who were capable of solving such problems now are gone, and we just can't find enough men who can do the jobs. I wonder, for example, if we realize how large was

* This is the text of an address before an Educators' Luncheon (at the Conrad Hilton Hotel) sponsored by the Chicago Chemical Progress Week Committee, May 18, 1955. Mr. Foster is president of the Manufacturing Chemists' Association, Inc.

the element of chance involved in our country's turning up Dr. Salk and his co-workers.

When our scientists have so greatly extended the range of our knowledge and so many benefits have been derived from this new knowledge, all within a short period, it is difficult for laymen to conceive that this progress may be nearing its limits.

But the simple fact is that a great many problems—physical, material problems—still exist and are serious, and new ones are being added as our civilization grows more complex. I am speaking of problems which can be solved only by extending the knowledge of our physical environment and how to use or control it.

Let me enumerate a few. The growing population in this country, which will add forty million more people by 1975, creates many of them. One is the fact that there is no foreseeable way to increase the acreage to supply these new people the agricultural products they must have. The only way we can do this is by increasing the yields of the acres we have or developing new ways to produce food and fibers, and this can be done only by science.

Another major problem is that of air and water pollution. Despite great progress in developing ways to abate pollution, it continues to grow simply because our population and our industry are growing.

Progress in the control of disease has been phenomenal, but think for a moment of the tremendous amount of suffering and economic loss caused by heart diseases, mental illnesses, and cancer, not to mention the common cold.

There is one more I must mention because right now it may be the most important problem of all. The atom bomb and H-bomb are realities on both sides of the world. Now the United States and Russia are engaged in a quiet but horrible struggle to see which will be the first to develop the intercontinental ballistics missile—the new IBM that no longer asks but forces you to think. The first who has it might well be able to dictate his terms to the other. From this development we might be either permanently slave or permanently free.

Some of the best scientists in the free world are working on our side, but the chilling fact is that in Russia there are scientists equally capable, and more of them are at work on these devices.

With all these problems, the one of American education may seem tame, but the fact is that it is basic to solving all of them. I wish we could make that fact clear to everyone—to every teacher, parent, taxpayer, legislator, official, and especially to every young person who is wondering what he will do with his life.

It becomes more clear when we realize that education of some sort is behind all the progress we are enjoying today. The science of chemistry and

what it has accomplished are outstanding examples. Chemistry and chemical change are part of nature, but the real wonder of our time is not the host of new products made available to us; it is the fact that we have learned to understand, use, and control chemical change so extensively.

This modern miracle is a triumph of the combined, total intellect of mankind. But minds uncultivated can no more produce such miracles than barren rocks produce wheat. No uneducated person, however intelligent, has accidentally stumbled across any of the great fundamental truths that made modern chemistry possible. These great discoveries, and even the little steps that have improved a product slightly or lowered a production cost, have only been developed by men with sufficient knowledge and training to lead them up to the discoveries and then enable them to recognize them when they got there.

These advances in knowledge are never the sole effort of one man. They are the results of the combined efforts of all the men working on a problem, plus the work of all men whose previous work is available. We are often struck by the fact that many advances are "discovered" almost simultaneously by two widely separated persons. The most obvious explanation, of course, is that both had access to the prior data. Today, both the complexity of the problems we face and the time within which we must solve them demand a great many men with sufficient intellect and education.

What I have been saying up to now may indicate that the chemical industry's only need for the technically trained is to advance knowledge through fundamental research. This, of course, is far from true. A look at chemical industry employment figures proves the point. The actual number has not increased too rapidly, but the proportion of technically trained personnel has risen sharply. The simple fact is that a modern technological industry like the chemical industry, as it develops more complex processes and operations, must have people with a higher degree of training and skill to run them.

Further, many products of the chemical industry can be used only by customers with enough education and training to understand them. A metal-fabricating plant, for example, which can cut costs or improve production by the use of one of these new chemical compounds must have someone trained in chemistry to supervise its use.

The company producing the chemical must have a salesman with sufficient training to understand his products and their potential uses and to explain the uses to his customer. One chemical sales executive who did not have the advantage of such training and had to learn his chemistry the hard way tells me he doesn't believe in hiring salesmen unless they have a degree in chemistry or chemical engineering The man without it has too much to learn these days to catch up and be competitive

The education problem is here right now. We do not need to look ahead five or ten years for the troubles it may give us. They will be worse then, probably, but any industrial executive can give you plenty of contemporary examples.

Growing American industry has already absorbed the increased number of technical or scientific graduates who took their training under the World War II veterans' benefits programs. Meanwhile, the number of graduates in these fields is steadily declining. Colleges and universities in this country granted more than 50,000 engineering degrees in 1950. In 1954 the number was slightly less than 20,000. There will be a slight increase this year, but not nearly enough to fill the needs. It is interesting to note that in Russia in 1954 there were almost 50,000 engineering graduates, compared with our less than 20,000. There are many such statistics, but a few weeks ago I came across a graphic example. One of the largest universities in the country, enrolling more than 20,000 full-time students, this year will graduate just six chemical engineers. Forty companies are trying to hire these six young men.

Faced with this problem, many of us in industry are trying to understand its causes and look for some effective and workable solutions. I have been interested to sit with a committee from our industry and struggle with one of the oldest problems of adults and parents: What are we going to do about our kids?

This is not a problem we can solve overnight. There is little we can do to increase the number of scientific or engineering graduates this year or next. Very little that we can do will show results for at least three years and will not really turn out the quantity and quality of men and women we need for another seven or eight. The young graduate is a long-term crop, and we are still doing a far from perfect job sowing the seeds.

Experts tell us that the determination of whether or not a young person will go into the fields of science or engineering is usually settled in the student's ninth or tenth year of school. If he does not then take the basic courses in science and mathematics, he either cannot qualify for the entrance requirements for college courses in these fields, or his lack of preparation will make such courses more difficult. More important is the fact that he is shut off from exposure to fields which might have sparked a strong latent interest.

The nub of our problem, then, is to give enough potential scientists and engineers in the ninth and tenth grades full opportunity to study the basic courses they need and to guide them in this direction. Why is this not happening? In face of the urgent needs of American industry and the welfare of our country and the great opportunities that are there for them, thousands of these young people with full potential for successful and

satisfactory careers in these fields can never have such careers because something doesn't happen when they are fourteen or fifteen.

The biggest cause for this condition, probably, is the over-all situation in public education As our population has grown, the educational system has not kept up. In physical plant it is estimated that we are more than 300,000 classrooms short of requirements. About 700,000 pupils in this country do not have full-time schooling. In half our classrooms there are more than the accepted desirable maximum of 30 pupils. The National Citizens' Committee for Education reports that $32.4 billion will be needed for school construction between now and 1965 to catch up with needs. That is about $3 billion a year. The current annual rate for such plant expenditures is less than $2 billion.

Our present operating expenditures for education are less than $10 billion a year, with plenty of indication that this sum is inadequate. One source estimates that this will have to be doubled in ten years. Neil H. McElroy, chairman of the White House Conference on Education and president of Procter and Gamble, predicts this budget must go up 50 per cent in the next few years.

This over-all condition of our educational system certainly is having its effect on reducing the number of qualified graduates in science or engineering. But there are other causes.

An important one is the lack of science and mathematics teachers. While school enrolment is steadily rising, the number of people preparing to teach science courses is dropping steadily. We can see no more than 3,600 new qualified teachers in these courses a year through 1960, from the best figures we can find; yet the number needed in 1954 was 7,700 and will climb to 21,700 by 1960.

Another contributing factor, I believe, is the elective system. The theory is—and I subscribe to it—that our young people will have a happier, better life if they can, with good guidance, select their own future as much as possible. The fact is, however, that they are not choosing science and mathematics courses in very large numbers. I do not believe this is entirely because they think these courses are too tough. Where such a choice is offered, they do not take it often because their natural interests have not been aroused. We find many schools with excellent guidance programs, but sometimes, unfortunately, the guidance counselors themselves are not sufficiently aware of the needs and opportunities in the technical fields.

These are some of the causes; here are some of their effects: The percentage of students in college preparatory chemistry has been declining steadily and was 7.6 in 1952. The percentage studying high-school physics has declined from about 23.0 at the turn of the century to 4.3 in 1952. Since 1910 the percentage studying plane geometry has declined every

year. In 1953–54 less than half our high-school students were studying any mathematics. About 20 per cent took algebra, 13 per cent geometry, and barely one in a hundred took trigonometry. Even if students want to study these courses, in many places they don't have the chance. Only about half of our secondary schools offer any course in chemistry.

This is a rough outline of the problem. Now what are we going to do about it? I have seen many solutions offered, many of considerable merit, but frankly I don't know the best answer. I can only contribute the thinking of my associates in the chemical industry and my own. The greatest reason for optimism is, as I have said, that so many are concerning themselves with it.

The first part of the problem that has to be solved is financing. We are now spending less than $10 billion a year on education. Competent experts tell us that our annual bill will be about $10 billion higher by 1965, or, in other words, will increase by about $1 billion each year for the next ten years.

This is the bill, and the first thing all of us must realize is that, if this problem is to be solved, this bill will have to be met. American industry, I am happy to say, is already carrying a very substantial share of these costs, not only through local, state, federal, and other taxes, but by giving large sums in grants, scholarships, fellowships, and other types of financial aid. Without committing any of my associates, I can assure you that American industry will continue to do its share and, as it expands, will provide even more.

But this problem is not confined to any one segment of our economy, such as industry. It is the responsibility of all of us. Our present annual bill for education is about $65 per person. By 1965, when our population will have grown to about 185 million, the expected annual cost will be about $100 per person. This is not a staggering increase in costs when compared with the current rates of increase in incomes and the general economy. As more and more people become aware of the importance of the problem, raising money will become one of its minor parts.

Another area we can and should do something about is that of teaching, particularly of science and mathematics. Let me say that this country is blessed with a strong corps of qualified science and mathematics teachers—capable and dedicated men, fully aware of their responsibilities and doing their best to discharge them in the face of obstacles. The fact that we now have technical and scientific leadership in the world is the result of their work as much or more than any other reason. Their contribution has been enormous. We cannot overestimate their importance.

But the need for more qualified teachers is growing steadily. The present corps simply cannot carry the additional burden and do the job of teaching

and inspiring that must be done. Somehow we must make up this shortage. We can do this only by inducing more young men and women to enter this field by making these teaching jobs more attractive from the standpoint of prestige and income.

In addition, industry must do all it can to aid in the job of teaching. Educators have demonstrated a degree of competence in their work fully equal to the standards in most of American industry, but we cannot expect them to develop the students needed in an isolated vacuum. We have large amounts of knowledge and information which, if prepared to fit their special needs, can help them do their job more effectively. Industry already is doing much in this field. It is a question not only of doing more but of refining techniques.

The area in which the most work is needed is with the students themselves. Even if we are able to provide the best teaching staffs, teaching materials, and adequate classrooms and laboratories, we have not accomplished our purpose unless we attract enough students with natural ability to take the necessary courses. What induces such a young person to take this preparation?

We often hear, perhaps crediting too much the sagacity of a fourteen-year-old, that the eventual income and job opportunities of the scientist or engineer are not great enough in comparison with the more difficult education he must have. The answer to this objection is easy. Starting salaries for technical graduates are the highest of any group. Their job security is probably better than any other group. Their opportunities for advancement are also better and are improving continually. In the chemical industry 57 per cent of all company executives hold degrees in science or engineering. In the highest echelons of management—vice-presidents, presidents, and board chairmen—55 per cent have such degrees. In other words, men with this type of education have greater opportunity than any other group for the top positions in our industry.

Personally, I do not believe the matter of opportunity is nearly so important as the interests of the individual student. If the pupil's interest can be aroused, provided he has the native ability and the opportunity to take the proper courses, he will do much of the subsequent preparation job himself. I think it is in this area that some of our most important work can and should be done.

I have been talking about some of the ways our problem can be helped, if not solved. Already a lot of work along these lines is in progress, and, as more of us get into it, our methods will improve, and the results will begin to show up. People in education and industry are earnestly trying to understand each other's problems and are improving their cooperation. Like sc

many big problems, this one probably will be solved by thousands of little steps.

Meanwhile, one big step is being made. In the last Republican Administration Mr. Hoover called a President's Conference on Education. That was more than a quarter of a century ago, but that conference had profound effects, the benefits of which we are still seeing. This November President Eisenhower has called the White House Conference on Education. Throughout this year states are holding preparatory conferences. The object of these state and national conferences is not to come up with a set of solutions but to study the problem in its true, national scope.

Limiting the objectives of this conference to study and definition of the problem is, I am convinced, the correct approach. While under sponsorship of the Executive Branch of the federal government, it recognizes that the problem is common to all of us and can be solved chiefly on the state and local basis.

As I and others have demonstrated, it is also a problem of industry, and it therefore becomes a direct consideration of industry management in planning and policy formulation. It is for this reason that the chemical industry, as represented by the Manufacturing Chemists' Association, is taking the most effective steps it can to support and assist this conference.

There is one caution, however, that must be expressed. I know of no area in our society about which there has been more conferring, and, while this has brought about many laudable results, we must recognize that it is no substitute for action. We know this is a slow business—that results will be many years in showing up. We also know that, on top of the time it takes to train a chemist or other scientist, it takes an average of seven years to complete a project in applied research and often much longer in fundamental research. We also know that the problems caused by the lack of sufficient numbers of people trained in science and engineering are here now and are growing steadily worse.

We do not have time to theorize, define, or cogitate indefinitely. As essential as these steps are, we must seek out whatever actions we can properly and effectively take, however limited they may be, and put them in motion. The way to begin is to commence.

As I have said, the American people and the people of our industry can be proud of the achievements being pointed out during this Chemical Progress Week. But I submit that any progress we will celebrate ten or twenty years from now will depend, more than anything else, on what we do now to bring our educational system into balance with our needs and the rest of our economy.

Your next **ROUND TABLE** *pamphlet*

THE RETURN TO RELIGION: FACT OR FICTION?

An NBC Radio Discussion by

JERALD C. BRAUER, dean, Federated Theological Faculty, University of Chicago

KERMIT EBY, professor, Division of the Social Sciences, University of Chicago

SIDNEY E. MEAD, associate professor, Federated Theological Faculty, University of Chicago

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